Dr. C.F. Vasile

From: "Dr. C.F. Vasile" <gfx-ch@msn.com>
To: <richard.karney@ee.doe.gov>
Cc: "Raymond McGowan" <rmcgowan@drintl.com>
Sent: Wednesday, April 30, 2003 2:11 PM
Attach: EF4.PDF; D&RI-WAP.PDF; HERS.PDF
Subject: Comments requested @ http://www.energystar.gov/index.cfm?c=new_specs.water_heaters

To: Mr. Richard H. Karney, P.E.
Manager, Energy Star Program
Building Technologies Program
US Department of Energy
1000 Independence Ave SW
Washington, DC 20585

From: Dr. Carmine F. Vasile
Ph.D., Electrophysics
CEO/President
WaterFilm Energy Inc.
Tel: 631-758-6271 Fax: 631-758-0438
www.gfxtechnology.com; gfx-ch@msn.com

Subject: "***Energy Star Labeling Potential Criteria for Water Heaters***"
D&R International, April 4, 2003

The main objective of these comments is to provide a technical basis for broadening D&R International's proposals by adopting recommendations in the 1996 report funded by Bill Noel, then Program Manager, Energy Star Program: "***Electric Water Heating Situation Analysis***", Reference #31186, Final Report to EEI/DOE December 6, 1996 by A.D. Little, Inc. (***ADL***). It can be downloaded via this link "Boosts Efficiency & Power Of Any Water Heating System" @ www.gfxtechnology.com.

Our fuel-neutral drain heat recovery (DHR) system (***GFX***) is one several technologies ADL selected because it can increase both energy factor and first-hour-rating of electric storage water heaters. They also recommended heat pumps (add-on & multifunction), solar, desuperheaters, point-of-use (instantaneous) and high-efficiency electric storage heaters, but only evaluated GFX with the latter. A stated goal of ADL's 1996 study to help develop future conservation programs, yet D&R International (***DRINTL***) failed to reference it or utilize its recommendations. This is particularly difficult for me to grasp because Alex Moore, D&R International, had this to say about GFX regarding DOE's Weatherization Assistance Program (WAP): "***…your product appears to qualify under Appendix A of 10 CFR 440 as either a water-to-water heat exchanger or as energy recovery equipment (under waste heat recovery devices).*** " (Quote from "D&RI-WAP" attachment)

Additionally, we wish to:

1. Demonstrate that fuel-neutral DHR technology recommended by ADL can boost the energy factor of new and existing gas, electric and oil-fired water heaters above the Energy Star levels proposed by DRINTL;
2. Suggest a cost-effective way to reduce peak-power demands of both gas & electric instantaneous water heaters, so the latter need not be deferred for future use as recommended in DRINTL's last Table (pg. 21);
3. Address Charlie Stephens' comment: ***There are critical flaws in the underlying structure of the* [D&R International] *proposals, as well as the analysis that seems to lead to them.***" (Quote from "Oregon Energy Office" link @ http://www.energystar.gov/index.cfm?c=new_specs.water_heaters);
4. Introduce a new set of energy factor equations requested by Sam Rashkin, National Director of the Energy Star Homes Program for use in HERS software. (See last section below and the "EF4" & "HERS" attachments)

Although these EF-equations were developed for use in HERS software, they can easily be applied to the gas, oil & electric water heating systems listed in DRINTL's tables (pp. 5, 10, 14, 16, 17, 21) and graphs (pp. 18, 19, 20) The recommendations of your predecessor's contractor (ADL) were never adopted by Energy Star for reasons discussed in the background section below and the September 2000 issue of Energy Design Update (***EDU*** , pp. 5,6). One of Mr. Noel's reasons for paying $35,000 on top of $65,000 EEI paid ADL was to identify potential Energy Star products that would offset the need for electric water heater standards at the efficiency level touted by some heat pump water heater manufacturers.

ADL did an excellent job; using EPRI's WATSIM computer program to perform self-consistent computations for all 5 DOE Climate Zones to account for large variations in coldwater temperature. (41F in Seattle to 77F in Tallahassee) Unlike the ADL report, which cites many references and authorities, there's no way to tell how

DRINTL arrived at some of its estimates because they provide no list of references. Both reports include evaluations of solar and heat pump water heating systems, but with significant discrepancies in estimated energy-savings.

In fact, most of our customers have used GFX to convert new or existing water heaters into power feedback water heaters (***PFWH***) having energy factors exceeding those of the new Federal standard, as well as those recommended by DRINTL for storage and instantaneous gas heaters. (See www.gfxtechnology.com/testimonials.html & "1st Power Feedback Water Heater (PFWH)" link @ www.gfxtechnology.com/gfx/contents)

The first paragraph in the section "***Alternative Storage-Type Water Heater Technologies***" (DRINTL, pg. 10) outlines a process by which solar and heat pump water heating systems could qualify for Energy Star labels. This process also applies to the remaining 12 ADL-systems listed in rows labeled A, D, E, F & G and the seven "GB" rows in the tables @ www.gfxtechnology.com/bundles.html.

For additional documentation to support our comments, please visit www.gfxtechnology.com and click on the following links:

1. Out-Saves Every ENERGY STAR Appliance
2. Gives an Electric Water Heater the Capacity of a Gas Heater
3. Performance Rivals HPWH
4. Enhances Solar Water Heater Performance
5. Boosts Efficiency & Power Of Any Water Heating System
6. Canadian R-2000/Energuide Energy-Credits: Electric 1760 kWh; Natural Gas 96 Therm = 9.9 MBtu = 2,815 kWh-thermal
7. Why America Should Follow Canada: A Trillion kWh Down-the-Drain

Link #5 also contains this note: "***Water Heating in Europe is much different; particularly in Germany, which has 7.2 million households with instantaneous systems and only 4 million households that use electric storage water heaters as their main hot water source; according to a report by the Austrian Energy Agency that may be downloaded from these links:*** *Summary (59 kB) Report (541 kB)*".

Germany's widespread reliance of instantaneous systems makes it difficult to rationalize DRINTL's recommendations against electric instantaneous water heaters for Energy Star. Oddly, DRINTL also warns against gas instantaneous water heaters on page 15 because they "***…place a much greater demand on the gas supply line***".

- If this is the case, DRINTL should have also recommended that DOE adopt ADL's recommendation to use a GFX to cut peak instantaneous gas demand the same way it cuts peak electricity demand --- by feeding back lots of power from shower drains.

If DRINTL determined GFX would qualify for the WAP and ADL determined it would qualify for Energy Star in 1997, it's difficult to grasp why DRINTL didn't recommended GFX and other DHR technologies for Energy Star in 2003.

Before setting Energy Star criteria, I pray you will include all 14 ADL-systems in these tables and use the ADL report to help cure "…***critical flaws in the underlying structure of the* [D&R International] *proposals, as well as the analysis that seems to lead to them.***"

Had DRINTL adopted or updated ADL's recommendations, Mr. Stephans may not have found so many "***critical flaws***", e.g.:

- Mr. Stephens was instrumental in Oregon becoming the only State to offer tax credits for DHR-technology. (See "1st State Tax Credits (OR): Res. – Com." links @ http://gfxtechnology.com/contents.html)
- GFX is the heart of one of 12 "***Completed Projects***" on DOE's Building Technologies Program. (See "*Drain water heat recovery system*" link @ http://www.eere.energy.gov/buildings/emergingtech/page3.html)
- ORNL recommended GFX for FEMP. (See "GFX in Greening Federal Facilities (.pdf)" link @ http://gfxtechnology.com/contents.html & www.gfxtechnology.com/links.html)

Background

In 1996, following my presentation at EPA headquarters, Sam Rashkin recommended GFX for Energy Star. Subsequently, DOE took jurisdiction over GFX, so in 1997 I made a similar presentation to Mr. Noel's staff. After

this presentation I was confident Energy Star would be incorporating all of the water heating technologies recommended by ADL, EEI and others. But in 2003, DRINTL concludes: "***Solar and heat pump technologies would be the only qualifying products in the electrical storage product class…***" --- despite omnipresent problems with residential HPWH performance and reliability. (See: "***Northeast Utilities Field Study Gives Crispaire HPWH Very Mixed Reviews***", ***EDU*** December 2001, pp. 3-5)

According to Mark Ginsberg, Deputy Assistant Secretary, Office of Building Technology, State and Community Programs, Energy Efficiency and Renewable Energy:

- "***In 1996, as a result of the Department's Notice of Proposed Rulemaking which proposed electric water heater standards that would have mandated the use of heat pump water heaters, Mike McGrath of the Edison Electric Institute approached Bill Noel, program manager for Doe's Energy Star program, about developing a voluntary program that would off-set the need for standards for electric water heaters at the efficiency level achieved by heat pump water heaters. Mr. Noel agreed to co-fund a study with EEI to evaluate various technologies that might meet the objectives of such a voluntary program. Subsequently EEI provided $65,000 and DOE provided $35,000 to fund a study that was conducted by A.D. Little. This study consisted of information gathering and theoretical estimates of energy savings from a number of the technologies, including the GFX.***"

- "***The results of this study were to be used to develop future voluntary programs. There were no plans to publish or distribute the report. The A.D.Little report entitled "Electric Water Heating Situation Analysis" was completed December 6, 1996, and submitted to EEI and DOE. Largely because DOE reconsidered the proposal to mandate efficiency standards that would have required heat pump water heaters, EEI lost interest in supporting a voluntary water heater program. While the report was never published, it was made available to anyone who requested it.***" (Quotes from Mr. Ginsberg's Memorandum of December 7, 2000, DOE File No. 100R5096)

Three Examples of "*Critical Flaws*"

1. According to Mr. Ginsberg, DOE Energy Star program spent "$35,000" to find ways to "***off-set the need for standards for electric water heaters at the efficiency level achieved by heat pump water heaters***". ADL succeeded beyond all expectations, but paragraph 4 of DRINTL's executive summary seems to mandate the use of heat pump water heaters for homes that cannot afford solar heaters, e.g.: "***Solar and heat pump technologies would be the only qualifying products in the electrical storage product class***" --- whereas spawn from the ***ADL*** report would have included many superior products in the storage and instantaneous product classes.
2. DRINTL failed to consider fuel-neutral, drain heat recovery (DHR) technology that ADL relied upon to boost the energy factor of these classes.
3. DRINTL seems to discriminate against electric instantaneous in favor gas instantaneous heaters; knowing power feedback versions of each would have energy factors off their charts. (For verification, simply compare the curves in the "EF4" attachment to their Table on page 21 and charts on pages 19 & 20.)

Energy Factor Equations Developed for HERS Software
Can Be Applied to Energy Star Labeling Criteria

Glenn Chinnery found no fault with the EF-equations developed for Mr. Rashkin to be used in HERS software. (See "HERS" attachment & next section) In his comments, Mr. Stephens reiterated the need for a reliable metric (EF) to allow consumers (and HERS raters) to perform "***apples-to-apples***" comparisons of Energy Star products. This can only be accomplished if every Energy Star product is held to the same standard and, in the special case of a heat pump water heater, there's no confusion between its EF, COP or COP_R. Note: COP_R is different from either Energy Factor or absolute COP and is more indicative of savings achieved, but DRINTL appears to have substituted HPWH-COP_R for EF on pages 13 & 17, e.g.:

- Page 13 cites a "...***heat pump water heater with an energy factor of 2.37***".
- But this type of HPWH could exhibit a huge spread in COP_R; 1.04 to 2.37 for the 30-HPWH set discussed in Footnote #1 and the December 2001 ***EDU*** article cited above.
- Yet the Table on page 17 seems to use an EF of ***2.4*** to estimate inflated energy-savings for the "Heat Pump" row.
- Savings estimates in the last 3 rows are therefore inflated as well.

Therefore, Mr. Stephans' raised a very important issue because Mr. Ginsberg wrote: "***The Energy Star label is used to identify the most efficient products on the market, usually to top 25 percent. If a water heater were sold with a GFX incorporated into it, it would probably qualify for the Energy Star label. The Department is not aware of any product like this being offered for sale on the market.***"

However, Adtec Systems Inc. manufactures an instantaneous power feedback water heater (PFWH) system "***with a GFX incorporated into it***" for water and/or space heating. Nevertheless, Mr. Ginsberg denied repeated requests for an Energy Star label; even our requests referred to him by EPA officials. In fact, a 12 kW PFWH using a Model G3-60 GFX can easily handle a 2.5 gpm shower with incoming water between 45 & 55F. This class of PFWH will comply with the maximum power standard of 10 CRF Part 430 (DRINTL pp. 7, 20). (See http://gfxtechnology.com/star_saver.PDF)

This same GFX could boost the performance of a solar or heat pump water heater for a relatively small increase in cost. To maximize the energy savings of a heat pump power feedback water heater (HP-PFWH), for example, its resistive element should be disconnected; allowing only GFX to boost its first-hour-rating. This will result in an EF close to 4, according to the HP-PFWH Equation (4) below, e.g.:

- **EF4(1,0.085,0.455,~2.6) ~ (0.915)(2.6)/[1 - (0.455)(0.915)] = 4** (See "Final Report: *Virginia Power Water Heater Testing and Optimization Project* (.pdf)" & "Part 3: Virginia Power's *Evaluation of a Drain Water Heat Recovery Device* (.pdf)" links @ www.gfxtechnology.com/tests.html)

Finally, GFX and every PFWH can be qualified for Energy Star the same way DRINTL proposes to qualify solar and heat pump water heaters in the section entitled "***Alternative Storage-Type Water Heater Technologies***" (pg. 10), e.g.:

- Solar, heat pump, and power feedback water heaters use storage technologies, but the current Federal standard does not define separate product classes for them. Each system uses basic storage technology, but heats the water using either solar energy, energy delivered from the surrounding space by a heat pump, or energy/power delivered by a heat exchanger such as a gravity film heat exchanger (GFX). Solar and heat pump and power feedback technologies typically use large storage tanks, although solar may use an integral storage tank and a GFX could be integrated with either a storage, heat pump, or instantaneous water heater. Since these water-heating technologies are often backed up with electrical resistance, the current electrical storage-type product class of the Federal standard best applies to each technology. DOE has rejected past petitions to create separate product classes for these technologies, and GFX for no logical reason.

In conclusion, WaterFilm Energy Inc. is a qualified "Residential Water Heater Stakeholder" because GFX is an integral part of Adtec's power feedback water heater and a key component of many "*Alternative Storage-Type Water Heater Technologies*". Accordingly, please post our comments @ http://www.energystar.gov/index.cfm?c=new_specs.water_heaters; supported by the attachments and the following section:

E-mail to Sam Rashkin, National Director of the Energy Star Homes Program
Re: Energy Factor Equations Developed for HERS Software

----- Original Message -----
From: Dr. C.F. Vasile
To: Rashkin.Sam@epamail.epa.gov
Cc: Chinery.Glenn@epamail.epa.gov
Sent: Friday, January 10, 2003 12:20 PM
Subject: Re: Energy Star & DHR

Sam Rashkin
National Director,
Energy Star Homes

Sam: I hope you had a great holiday. I've been busy addressing concerns raised in your E-mail below.

I believe the following energy factor equation can be used in HERS software:

$$EF4(Kc,EF,Kg,Kp) = [1 + (Kp - 1)/Kc](EF)/[1 - (Kg/Kc)(EF)] \quad (1)$$

It's a function of the 4 variables (Kc, EF, Kg, Kp) defined in Footnote #1 because it covers 4 classes of water heaters:

1. Electric (Kc = 1),
2. Fossil fuel (Kc<1),
3. Power feedback (PF), with Kg = 0.455 for a Model G3-60 GFX;
4. Heat pump (HP), with Kp = 1.53 for an E-Tech add-on HPWH.

Additional variables and terms can be added to cover desuperheaters, solar collectors, ground source heat pumps, etc. (See Footnote #2)

Unbiased Analytical Findings

Regarding your "....***recommendation is to get a recognized expert/authority to provide us with the unbiased analytical findings on the increase in EF with GFX***", **EEI** got Virginia Power to do this in 1995 when they arranged to have GFX added to the ***Virginia Power Water Heater Testing and Optimization Project*** then under DOE's EADC/IAC Team at Old Dominion University. Unbeknownst to me until late 2001, Virginia Power had secured a exclusive sublicense-right to market GFX in Virginia, North Carolina, and the Federal Government. They needed "***unbiased analytical findings***" for these markets.

The Old Dominion Team measured energy factor, first-hour rating and standby loss of 11 types; summarized in tables @ www.gfxtechnology.com/tests.html. This Web page also includes links:

To DOE's Uniform Test Method for Water Heaters: 10CFR Pt. 430, Subpt. B, App. E (.pdf)

Final Report: *Virginia Power Water Heater Testing and Optimization Project* (.pdf)

Part 3: Virginia Power's *Evaluation of a Drain Water Heat Recovery Device* (.pdf)

"*Outperforms heat pump water heater*" (*EDU* 12/96 .pdf)

"*Gives an electric water heater the capacity of a gas heater*" (*EDU* 12/96 .pdf)

The latter links are from an independent, unbiased evaluation by Ned Nisson, Energy Design Update's (***EDU)*** former Editor. The current ***EDU*** Editor recently reviewed an independent evaluation of E-Tech's successor as discussed in Footnote #1.

Page 38 of Old Dominion's final report begins a section entitled "***Determining Energy Factor and Hourly Standby Loss***". As noted, it adhered to the 1996 version of Appendix E to Subpart B of 10CFR430, except a 120F set-point was used instead of 135F as specified in Section 6.2.4 ***Energy Factor***. According to Definition 1.4, ***Energy Factor means a measure of water heater overall efficiency.***" This definition enables an "apples-to-apples" comparison using Equation (1) above because it constrains the output energy ("Eout") over a 24-hour test period to be a constant. Input fuel or electricity is automatically adjusted during the test period such that the ratio "**Eout/Ein**" represents a consistent measure of energy factor for any water heating system.

- According Appendix E, Section 7. ***Ratings for Untested Models*** (pg. 162) I believe evaluations of the Model G3-60 GFX on the Virginia Power Project should apply to GFX models rated within +/-10% of its DHR-Efficiency (60% @ 2.25 gpm, balanced flow). From the TABLE @ http://gfxtechnology.com/contents.html#selection we see this includes the following models: **G4-60, G4-40, S3-60, S4-60, S4-40, P3-40, P3-30, PS4-60, G3-60-3, and G4-80-4**.

NOTE: After the Virginia Power report had been released, I was asked for help by ORNL, Virginia Power & DOE to develop EF equations that could have been used in HERS software. Apparently you never saw them.

After receiving your E-mail, I decided to expanded them to cover more than the 11 types evaluated on the Virginia Power Project so HERS software developers could cross-check Equation (1) against their computer models. As illustrated by the examples below and the "EF4" attachment, this new equation can handle most residential gas, oil & electric water heaters.

I've also been asked by many for GFX's "Operating-EF" to account for distribution loss, batch-loss, feeding heat forward to showers with & without feeding back power to the WH. Feeding power forward to fixtures, for example, is not allowed for in Appendix E, so an "Operating-EF" cannot be used for comparison purposes. Similarly, heat taken from space heaters is absent from the calculation of a HPWH's EF. Long hot water draws at high flow rates lowers both Kp & Kc for different reasons. GFX's DHR-efficiency drops at high flow rates. If the upper element of a HPWH is disconnected, its Kp will approach the HP's COP, but the first-hour rating will drop. The HPWH's first-hour rating measured on the Virginia Power Project ranged from 46 to 60 gallons with its upper element active. GFX would have boosted this to around 108 to 180 gallons, but this case was not evaluated. This link "**Heat Transfer Tables & Curves**" @ www.gfxtechnology.com/contents.html shows the DHR-efficiency of a G3-60 GFX drops from 70% to 46% as its balanced-flow-rate increases from 1 to 5 gpm. The Virginia Power Project used flow rates up to 6 gpm in the test procedure discussed in the "OldDomEx" attachment; Appendix II ***The Testing System & Procedures***. This 6 gpm flow was high enough and long enough to lower GFX's Kg & the HPWH's Kp because of prolonged upper element energization. Additionally:

- The "BPA-GFX" attachment shows how the BPA handled these issues; very conservatively as discussed in FOOTNOTE #3;
- Page 6 of the "CZWYR-2000" attachment gives a heat recovery factor of 0.345 to account for some of the energy missed by GFX from batch operations.
- No DOE evaluation accounts for the huge spread of residential hot water usage; 3139 to 9877 kWh/yr without GFX per this link **1st Low Income Housing Program By PP&L** @ www.gfxtechnology.com/contents.html.

Application of Equation (1) to the Virginia Power Project

Case A: PFWH (Kc =1, Kg =0.455, Kp =1):

$$EF4(1,EF,0.455,1) = (EF)/(1 - 0.455EF) \quad (2)$$

Case B: HPWH (Kc =1, Kg =0, Kp =1.53):

$$EF4(1,EF,0,1.53) = 1.53EF \quad (3)$$

Case C: HP-PFWH (Kc =1,Kg =0.455, Kp =1.53):

$$EF4(1,EF,0.455,1.53) = 1.53(EF)/(1 - 0.455EF) \quad (4)$$

Equations 2, 3 & 4 are plotted in the "EF4" attachment. To check them, I plotted 7 data points (A-G) from the tables @ www.gfxtechnology.com/tests.html to show they fall on or near their respective curves; well within the EF-spread obtained from repeated measurements on the Virginia Power Project.

Applying Equation (1) to Gas Water Heaters, etc.

The Takagi T-K2 tankless gas water heater advertises an EF = 0.84 and Kc = 0.85, so Equation (1) indicates a G3-60 GFX will boost its energy factor to: **0.84/[1 - (0.455/0.85)(0.84] = 1.53**. This falls near the PFWH curve in the "EF4" attachment because Kc is fairly high.

By comparison, an electric PFWH like "A-Star" (www.adtectankless.com/star_saver.html), will have an EF near 0.99, so Equation (1) predicts its energy factor will be: **0.99/[1 - (0.455)(0.99] = 1.8**. This falls on the PFWH curve in the "EF4" attachment because Kc = 1.

Indirect Gas Water Heater

Consider a Takagi T-K2 used as an indirect water heater with a poorly insulated tank and a net energy factor of 0.55; near that of an inexpensive gas storage water heater like a 50 gallon Rheem Vanguard Model, for example. Equation (1) indicates a G3-60 GFX will boost its energy factor to: **0.55/[1 - (0.455/0.85)(0.55)] = 0.78**.

But the Vanguard has a much lower fuel-conversion factor (Kc ~ 0.76), so Equation (1) indicates a G3-60 GFX will boost Vanguard's energy factor to: **0.55/[1 - (0.455/0.76)(0.55)] = 0.82**. This falls well above the PFWH curve in the "EF4" attachment because thermal-power fed back by GFX has no associated gas-conversion loss.

An oil-fired water heater could have a much lower conversion factor (Kc ~ 0.6 with an energy factor of 0.5), so Equation (1) indicates a G3-60 GFX will boost its energy factor to: **0.5/[1 - (0.455/0.6)(0.5)] = 0.8**. This also falls well above the PFWH curve in the "EF4" attachment because thermal-power fed back by GFX has no associated oil-conversion loss.

These examples indicate GFX can give a significant boost in the energy factor of cheap gas water heaters that builders like to install in new or Energy Star homes. It also explains why R-2000/Energuide energy credits are 1.6 times higher for gas than electric water heaters; as noted in this link **Canadian R-2000/Energuide Energy-Credits: 1760 kWh (Electric); 96 Therm = 9.9 MBtu = 2,815 kWh-thermal (Natural Gas) (.pdf)** @ **www.gfxtechnology.com**.

"HP-PFWH" for Energy Star & Zero Energy Homes

For some unknown reason, three HP-PFWH's were not evaluated on the Virginia Power Project. But they are needed in Zero-Energy & all-electric Energy-Star homes. For this case, Equation (1) with Kc = 1, EF = 0.915, Kg = 0.455, Kp = 1.53 yields:

EF4(1,0.085,0.455,1.53) = (0.915)(1.53)/[1 - (0.455)(0.915)] = 2.4

An EF of 2.4 is close to the HP's absolute COP, but the first-hour rating will be near 108-180 gallons; not 46-60 gallons as measured on the Virginia Power Project. In fact, Kp would be higher because GFX would delay upper element energization. If the upper element were to be disconnected, Kp ~ 2.6 and Equation (1) yields:

EF4(1,0.085,0.455,~2.6) ~ (0.915)(2.6)/[1 - (0.455)(0.915)] = 4

- Therefore, GFX may make it practical to disconnect the upper element of a residential HP-PFWH to keep it in the HP-mode all the time.

CONCLUSION

I believe Equation (1) is validated to EPA standards because it accurately predicts results from the Virginia Power Project. All

HERS raters have to do is input realistic values (+/- 10%) for the 4 variables into Equation (1). EF & Kc are provided by water heater manufacturers. The COP provided by HP manufacturers must be derated unless the upper element is disconnected to force a 100%-HP operation. Kg for a G3-60 GFX has been determined on the Virginia Power Project. Other models should be allowed without a need for re-testing under 10CFR430 Subpt. B, App. E, Sections 7, 7.1, 7.2.

Your Energy Star Homes program can benefit from GFX in two ways.

1. It significantly raises the EF of any residential water heater.
2. It significantly raises first-hour ratings to allow smaller water heaters to be installed.

According to page 158 of App. E, the standby loss heat coefficient ("UA") is proportional to an area ("A"). Although lower standby loss is reflected in an EF-rating, HERS raters should award GFX extra Energy-Star points to promote the use of smaller or tankless water heaters to reduce or eliminate standby loss.

Best regards,
Carmine

FOOTNOTES

1. Variable definitions (Kc, EF, Kg, Kp) measured in accordance with DOE's Uniform Test Method for Water Heaters: 10CFR Pt. 430, Subpt. B, App. E.

- **Kc** is an average fuel-conversion factor; **~** 1 for most electric, ~ 0.76 for cheap gas & ~ 0.6 for cheap oil water heaters;
- **EF** is the energy factor of a basic water heater without energy saving appliances;
- **Kg** is a heat recovery factor accounting for the average energy fed back by GFX during DOE's 24-hour test procedure;
- **Kp** is close to the COP_R of a HP-assisted water heater, but different from its energy factor. It's lower than the HP's absolute COP because upper element energization is caused by long hot water draws during DOE's 24-hour test procedure in 1996. If the upper element is disconnected, Kp goes up but the first-hour rating drops. **Note**: COP_R is more indicative of savings achieved by an add-on HPWH; about 1.705+/- 0.665 according to "***Northeast Utilities Field Study Gives Crispaire HPWH Very Mixed Reviews***" (***EDU*** 12/01) This HPWH is the modern version of the E-Tech model evaluated on the Virginia Power Project. Application of Equation (1) results in **Kp** = 1.53 +/- 0.04; well within the measured spread of EF values posted in the 2nd Table @ www.gfxtechnology.com/tests.html and the COP_R spread measured in NE Utilities' field study.
- Energy & power captured, stored and fed back by GFX experiences no fuel-conversion-loss, but is subjected to standby loss.
- Energy pumped from air by a heat pump experiences no fuel-conversion-loss, but is also subjected to standby loss.
- The Virginia Power Project team did not evaluate GFX with a HPWH. If they had, the resulting "HP-PFWH" would have given the best EF because GFX would have reduced upper element energization.

2. **Conservation Energy Constraint**: **Eout = (Kc)(1-Ks)Ein + (1-Ks)(Kp - 1)Ein + (1-Ks)(Kg)Eout + terms for solar panels, desuperheaters, etc.** **Note**: With no HP or GFX, **Eout = (Kc)(1-Ks)Ein** so **EF = (Kc)(1-Ks)**; the energy factor of a basic water heater having a standby loss factor, **Ks = 1-(EF/Kc)**, with **Kc** & **EF** values set by DOE's 24-hour test procedure.

3. Charlie Stephens of the Oregon Energy Office notified me that a HPWH & GFX are slated for Oregon's Zero Energy Homes. Charlie was the only State official willing to fight for the GFX tax credits per these links **1st State Tax Credits (OR): Res. – Com.** @ www.gfxtechnology.com/contents.html. I believe this influenced BPA's C&RD Program, wherein GFX has a "***Deemed Savings***" designation with associated wholesale rebates to utilities supplied power by the BPA.

- The "BPA-GFX" attachment includes 18 C&RD-schedules for various GFX installations, using a 30" S3-30 as opposed to a 60" S3-60; with very conservative savings estimates compared to those for a HPWH in the "BPA-HPWH" attachment. (This savings-disparity is inconsistent with GFX & HPWH savings summarized @ www.gfxtechnology.com/bundles.html, based on the AD Little report for DOE & EEI.)
- Some of Oregon's Zero Energy homes will use a HPWH manufactured by Florida Heat Pump. GFX will convert them into a reliable "HP-PFWH" to cut the number of PV panels. For example, applying GFX's R-2000 Energy Credit of 1760 kWh would off-set about 900 kW of PV panels worth about **$4,500** with a subsidized cost of $5,000 per kW of net-metered PV-power.

----- Original Message -----
From: <Rashkin.Sam@epamail.epa.gov>
To: "Dr. C.F. Vasile" <gfx-ch@msn.com>
Cc: <Chinery.Glenn@epamail.epa.gov>

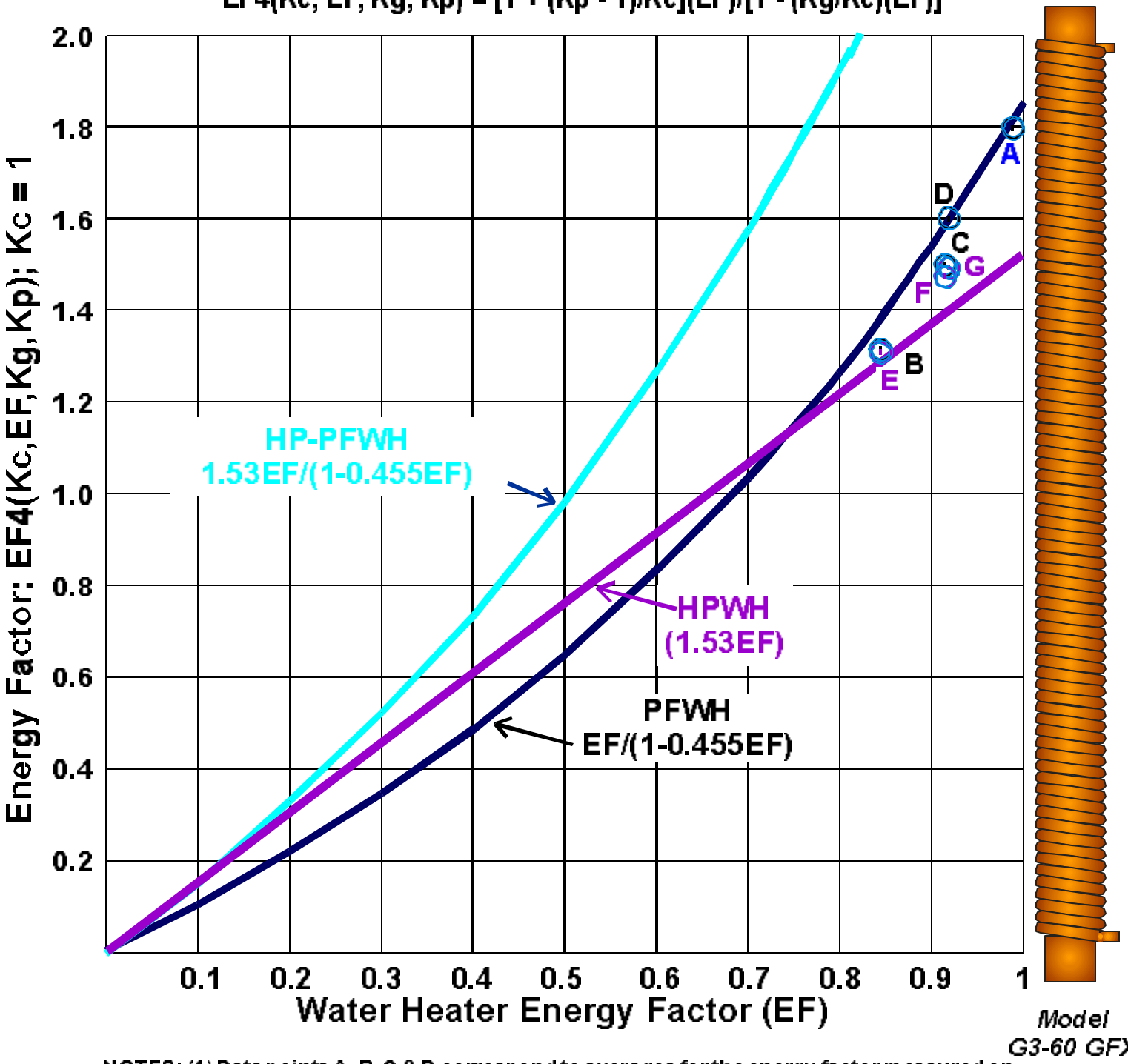
Sent: Friday, December 20, 2002 8:47 AM
Subject: Re: Energy Star & DHR

Carmine:
I need time to consider your suggestions, but unfortunately I'm out for two weeks for the holidays after today. Thus, if I don't get back to you until 1st/2nd week of January, please understand. However, one quick point until then. HERS software need an EF input for water heating. Thus, if you want the HERS infrastructure to embrace your technology, it has to be easy for them to include it in their analysis. Using just the kWh savings doesn't accomplish that and leaves too many customized variations trying to adjust the software calculated score after the fact. So, my strong recommendation is to get a recognized expert/authority to provide us with the unbiased analytical findings on the increase in EF with GFX. Have a great holiday.
****

Sam Rashkin
U.S. EPA
ENERGY STAR for Homes
1200 Pennsylvania Ave., NW (6202J)
Washington D.C., 20460
(202) 564-9786; fax (202) 565-2134
rashkin.sam@epa.gov
www.energystar.gov/homes

Validating Energy Factor Equation:

EF4(Kc, EF, Kg, Kp) = [1 + (Kp - 1)/Kc](EF)/[1 - (Kg/Kc)(EF)]



NOTES: (1) Data points A, B, C & D correspond to averages for the energy factor measured on 4 PFWH's using a Model G3-60 GFX with a 13.5-kW tankless and three 50-gallon storage-type electric water heaters on the *Virginia Power Water Heater Testing and Optimization Project*. Data points E, F & G correspond to averages for an add-on HPWH measured with the 3 storage water heaters. (2) The 7 data points (A to G) correspond to these water electric heaters: A - Tankless, B & E - Standard, C & F - Plastic, D & G - Stone Lined; from the tables @ www.gfxtechnology.com/bundles.html, which also includes first-hour rating & standby loss measurements; all in accordance with DOE procedures of 10CFR430 Subpart B, Appendix. E.

Dr. C.F. Vasile

From: <Rashkin.Sam@epamail.epa.gov>
To: "Dr. C.F. Vasile" <qfx-ch@msn.com>
Cc: <Chinery.Glenn@epamail.epa.gov>
Sent: Monday, January 13, 2003 10:34 AM
Subject: Re: Energy Star & DHR

Carmine:
Nice job assembling the information we asked for. Glenn Chinery, our technical coordinator, is now reviewing it for any possible comments before we vet it with HERS representatives at the RESNET Conference in San Diego (for info this HERS industry conference, see www.natresnet.org). Coordinating with the HERS industry should be very beneficial because it can develop their 'buy-in' for any forthcoming policy on incorporating GFX technology it in a HERS rating. Hopefully, we should be able to make a final policy decision by early spring.
THANKS.
****

Sam Rashkin
U.S. EPA
ENERGY STAR for Homes
1200 Pennsylvania Ave., NW (6202J)
Washington D.C., 20460
(202) 564-9786; fax (202) 565-2134
rashkin.sam@epa.gov
www.energystar.gov/homes

Dr. C.F. Vasile

From: "Dr. C.F. Vasile" <gfx-ch@msn.com>
Sent: Friday, April 25, 2003 10:52 AM
Subject: WAP & D&RI

----- Original Message -----
From: Alex Moore
To: Dr. C.F. Vasile
Sent: Friday, October 25, 2002 12:16 PM
Subject: RE: Award-Winning Technology As New Weatherization Assistance Approved Measure

Dr. Vasile,

The U.S. Department of Energy's (DOE's) policy for approving new materials for use in the Weatherization Assistance Program is that the request must come from a state interested in using the material in their program. The state, not the vendor, must submit the material, together with technical documentation.

However, after a quick review, your product appears to qualify under Appendix A of 10 CFR 440 as either a water-to-water heat exchanger or as energy recovery equipment (under waste heat recovery devices). Provided your product complies with the applicable ASME, TEMA, or SMACNA standards listed in Appendix A, states may purchase your product as an allowable Weatherization measure if they choose. Because a material is allowable (assuming compliance with applicable standards) does not relieve states of the requirement to analyze each specific potential installation of the material and ensure that the resulting energy cost savings over the lifetime of the measure, discounted to present value, equal or exceed the total cost of the measure.

Being a Federal agency, DOE cannot endorse any specific commercial product or brand. For this reason, marketing materials (print, on-line, or other) must not indicate or imply that DOE has a specifically approved a particular commercial product or brand for use in the Weatherization Assistance Program. However, marketing materials may indicate that a product complies with applicable standards listed in Appendix A under particular categories and, therefore, is an allowable Weatherization material.

==========
Alex Moore
D&R International, Ltd.
1300 Spring Street, Suite 500
Silver Spring, MD 20910
Phone: (301) 588-9387
Fax: (301) 588-0854

-----Original Message-----

From: Dr. C.F. Vasile [mailto:gfx-ch@msn.com]
Sent: Friday, October 25, 2002 9:22 AM
To: Alex Moore
Subject: Award-Winning Technology As New Weatherization Assistance Approved Measure

Alex Moore
D & R International
Rockville, MD
301-588-9387
www.drintl.com

Dear Mr. Moore: Per Ms. Powere's suggestion below, please list our award-winning drain heat recovery (DHR) technology as a Weatherization Assistance Approved measure and add it to the schedule of tested equipment. See www.gfxtechnology.com/bundles.html for the DOE Grant evaluation of GFX. Other third-party evaluations are linked from www.gfxtechnology.com & www.gfxtechnology.com/contents.html.

Since the "10CFR440-App-A" attachment (Appendix A of 10CFR440) governs acceptance for use in the Weatherization Assistance program (WAP), I think you will agree that GFX will qualify under the following 7 categories:

1. Heat Exchangers (pg.5) --- Operating unflooded or flooded, a Gravity Film Heat eXchanger (GFX) offers heat transfer coefficients within the top 25% of any type of double-wall-vented heat exchanger and many single wall types. The low pressure drop of GFX in some flooded & unflooded applications makes it the best choice. For example, 222 G2-12's add no pressure drop when inserted in the main recirc loop per this link Save Water Safely In Condos, Hotels, Dorms, etc. (.pdf) @ www.gfxtechnology.com/contents.html. We have also quoted large, multi-coil GFX's for insertion to protect geothermal heat pumps from harmful well-water and cross-contamination of potable water supplies. A recent application in a Wisconsin Ski Resort calls for 40 GFX Drain Heat Recovery systems plus other GFX's to protect the geothermal heat pumps that help heat the buildings by pumping heat from well-water fed to snow-making machines. (As a bonus, cooling well-water extends the snow-making season.)
2. Water Heater Modifications (pg. 6) --- As a Power Booster, the Old Dominion report summarized @ www.gfxtechnology.com/tests.html reveals that GFX simultaneously boosts First Hour Rating & Energy Factor by shaving peak water heater loads and preventing upper element energiztion during large water draws. HPWH's covered on Appendix A, pg. 6 could benefit from a GFX "Tune Up" that'll make it operate longer in the HP mode by reducing upper element energization. Lower shower-loads permits lower boiler set-points to reduce standby-loss and slow lime buildup. (When I installed the 1st UL-approved GFX in my house, it cut the peak shower load on our tankless-coil oil-fired water heater by about 34,000 Btu/hr so the oil-burner began to cycle on/off with the shower on. Before GFX its limed-coil made the burner run continuously when the showere was on, yet we still ran out of hot water.)
3. Solar Water Heating Systems (pg. 6) --- A utility field test in Connecticut showed GFX matched the solar water heater's contribution to the total water heating load. GFX also helped NREL win an ASHRAE award for the off-the-grid vanGeet house.

4. Waste Heat Recovery Devices (pg. 6) --- A far as I know, GFX is the only one that doesn't need a code variance as do storage types like EarthStar, DrainGain & others;
5. Replacement Water Heaters (pg. 6) --- This link 1st Power Feedback Water Heater (PFWH) @ www.gfxtechnology.com/contents.html tells about A-Star; an ideal Replacement Water Heater & solar backup. This link Save More Than Any Energy Star Appliance (.pdf) @ www.gfxtechnology.com shows how much energy A-Star can save compared to high efficiency storage water heaters.
6. Boiler Repair and Modifications/Efficiency Improvements (pg. 7) --- As a Power Pooster, GFX reduces the load on any water heating system so it could qualify as an Efficiency Improvement for every WAP project.
7. Heating and Cooling System Repairs and Tune-Ups/Efficiency Improvements (pg. 8) --- As a Power Pooster, GFX reduces the load on any water heating system so it could also qualify as a Tune-Up/Efficiency Improvement.

If you do agree with the above, how do we proceed?
I'd like to post something official on our Web site like we have for Oregon's tax credits.

Regarding GFX's cost, the DOE report summarized @ www.gfxtechnology.com/bundles.html used an installed cost of $300 for a G3-60 GFX based upon large quantity discounts I will make available for WAP wherever possible.

PP&L used an "inflated" installed cost of $500 for whole house (S3-60) models, See 1st Low Income Housing Program By PP&L @ www.gfxtechnology.com/contents.html.

Finally, the "PPL-GPU-EA" attachment corresponds to two programs now in effect in PA. I think these forms could be easily adapted for WAP.

Thank you for your cooperation,

==========

Dr. Carmine F. Vasile, President
WaterFilm Energy Inc.; P.O. Box 128; Medford, NY 11763
USA Rep for Doucette Industries; Except: WA, OR, ID, MT,
CA, NV, UT, WY, CO, AZ, NM, AK, HI
Tel: 631-758-6271 Fax: 631-758-0438
Email: gfx-ch@msn.com Web: www.GFXtechnology.com

==========

----- Original Message -----
From: Meg Power
To: gfx-ch@msn.com
Sent: Monday, October 21, 2002 1:06 PM
Subject: re heat system technology

NCAF is a lobbying group for local CAAs and does not have programs. To get your equipment listed as a Dept of Energy Weatherization Assistance Approved measure, it must be on the schedule of tested equipment - to qualify, submit your info to amoore@drintl.org, alex moore at D & R International in Rockville MD.

<snipped>

Good luck
Meg Power